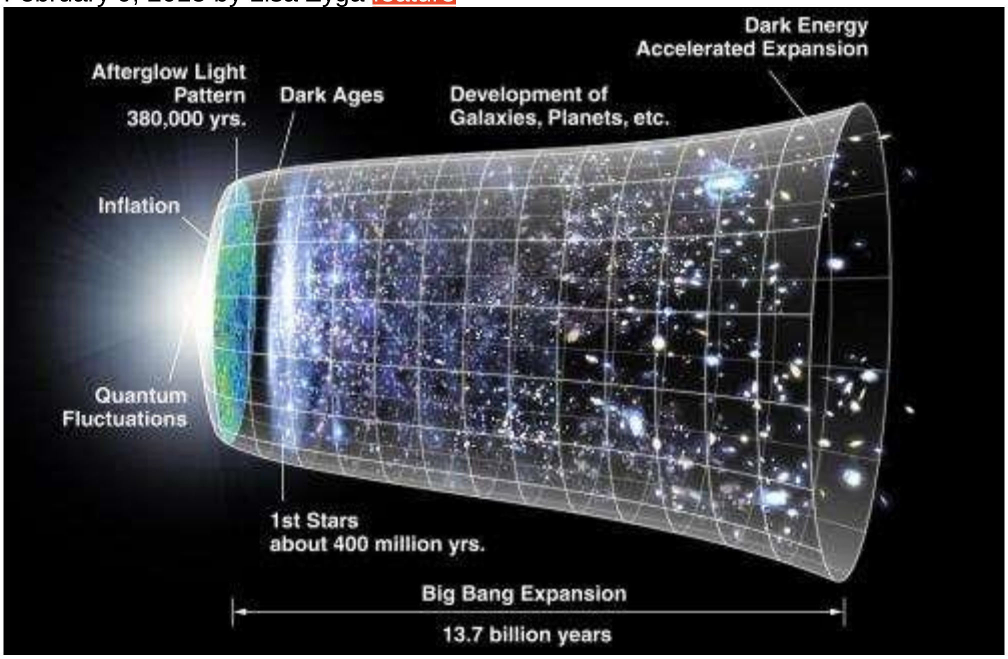
No Big Bang? Quantum equation predicts universe has no beginning

February 9, 2015 by Lisa Zyga feature



This is an artist's concept of the metric expansion of space, where space (including hypothetical non-observable portions of the universe) is represented at each time by the circular sections. Note on the left the dramatic expansion (not to …more

(Phys.org) —The universe may have existed forever, according to a new model that applies quantum correction terms to complement Einstein's theory of general relativity. The model may also account for dark matter and dark energy, resolving multiple problems at once.

The widely accepted age of the universe, as estimated by general relativity, is 13.8 billion years. In the beginning, everything in existence is thought to have occupied a single infinitely dense point, or singularity. Only after this point began to expand in a "Big Bang" did the universe officially begin.

Although the Big Bang singularity arises directly and unavoidably from the mathematics of general relativity, some scientists see it as problematic because the math can explain only what happened immediately after—not at or before—the singularity.

"The Big Bang singularity is the most serious problem of general relativity because the laws of physics appear to break down there," Ahmed Farag Ali at Benha University and the Zewail City of Science and Technology, both in Egypt, told *Phys.org*.

Ali and coauthor Saurya Das at the University of Lethbridge in Alberta, Canada, have shown in a paper published in *Physics Letters B* that the Big Bang singularity can be resolved by their new model in which the universe has no beginning and no end.

Old ideas revisited

The physicists emphasize that their quantum correction terms are not applied *ad hoc* in an attempt to specifically eliminate the Big Bang singularity. Their work is based on ideas by the theoretical physicist David Bohm, who is also known for his contributions to

the philosophy of physics. Starting in the 1950s, Bohm explored replacing classical geodesics (the shortest path between two points on a curved surface) with quantum trajectories.

In their paper, Ali and Das applied these Bohmian trajectories to an equation developed in the 1950s by physicist Amal Kumar Raychaudhuri at Presidency University in Kolkata, India. Raychaudhuri was also Das's teacher when he was an undergraduate student of that institution in the '90s.

Using the quantum-corrected Raychaudhuri equation, Ali and Das derived quantum-corrected Friedmann equations, which describe the expansion and evolution of universe (including the Big Bang) within the context of general relativity. Although it's not a true theory of quantum gravity, the model does contain elements from both quantum theory and general relativity. Ali and Das also expect their results to hold even if and when a full theory of quantum gravity is formulated.

No singularities nor dark stuff

In addition to not predicting a Big Bang singularity, the new model does not predict a "big crunch" singularity, either. In general relativity, one possible fate of the universe is that it starts to shrink until it collapses in on itself in a big crunch and becomes an infinitely dense point once again.

Ali and Das explain in their paper that their model avoids singularities because of a key difference between classical geodesics and Bohmian trajectories. Classical geodesics eventually cross each other, and the points at which they converge are singularities. In contrast, Bohmian trajectories never cross each other, so singularities do not appear in the equations.

In cosmological terms, the scientists explain that the quantum corrections can be thought of as a cosmological constant term (without the need for dark energy) and a radiation term. These terms keep the universe at a finite size, and therefore give it an infinite age. The terms also make predictions that agree closely with current observations of the cosmological constant and density of the universe.

New gravity particle

In physical terms, the model describes the universe as being filled with a quantum fluid. The scientists propose that this fluid might be composed of gravitons—hypothetical massless particles that mediate the force of gravity. If they exist, gravitons are thought to play a key role in a theory of quantum gravity.

In a related paper, Das and another collaborator, Rajat Bhaduri of McMaster University, Canada, have lent further credence to this model. They show that gravitons can form a Bose-Einstein condensate (named after Einstein and another Indian physicist, Satyendranath Bose) at temperatures that were present in the universe at all epochs.

Motivated by the model's potential to resolve the Big Bang singularity and account for dark matter and dark energy, the physicists plan to analyze their model more rigorously in the future. Their future work includes redoing their study while taking into account small inhomogeneous and anisotropic perturbations, but they do not expect small perturbations to significantly affect the results.

"It is satisfying to note that such straightforward corrections can potentially resolve so many issues at once," Das said.

Explore further: Theorists apply loop quantum gravity theory to black hole

More information: Ahmed Farag Ali and Saurya Das. "Cosmology from quantum potential." *Physics Letters B*. Volume 741, 4 February 2015, Pages 276–279. DOI: **10.1016/j.physletb.2014.12.057**. Also at: **arXiv:1404.3093**[gr-qc].
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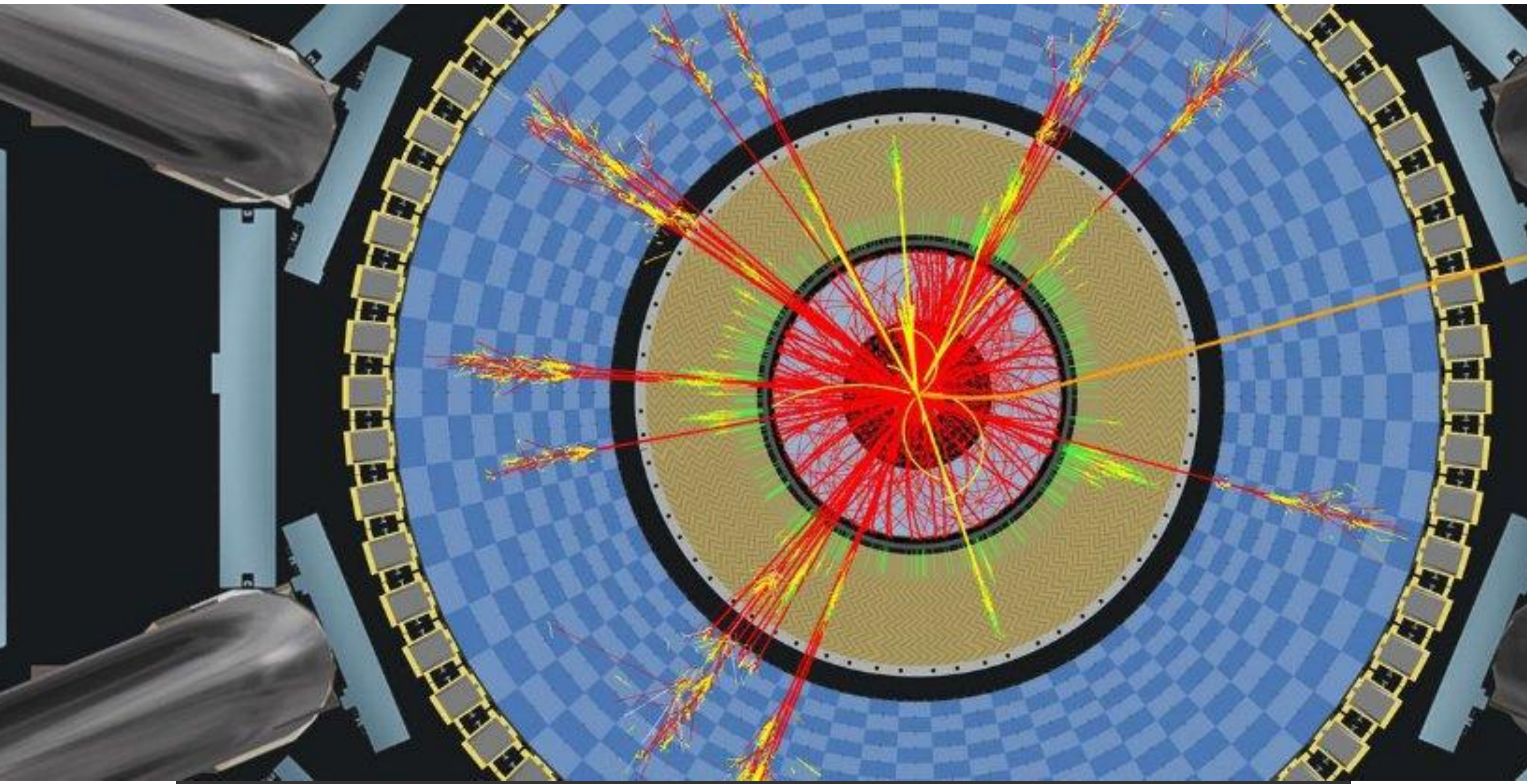

CERN

It's official: We haven't found a new fundamental particle

The Standard Model remains in tact, for now...

FIONA MACDONALD

5 AUG 2016

Well, we called it earlier today, and now it's official. CERN has announced that, for the present at least, we haven't detected a brand new particle capable of breaking the Standard Model of particle physics.

If you've been following the story so far, you'll know that the news comes as a blow for many physicists who've spent the past seven months coming up with possible explanations for this new particle.

(And if you're playing along with our CERN announcement drinking game, you should have finished your glass by now).

CERN made the announcement this morning at the International Conference of High Energy Physics (ICHEP) in Chicago, alongside a huge slew of new Large Hadron Collider (LHC) data.

"The intriguing hint of a possible resonance at 750 GeV decaying into photon pairs, which caused considerable interest from the 2015 data, has not reappeared in the much larger 2016 data set and thus appears to be a statistical fluctuation," CERN announced in a press release sent via email.

Why did we ever think we'd found a new particle in the first place?

Back in December, researchers at CERN's CMS and ATLAS experiments smashed particles together at incredibly high energies, sending subatomic particles flying out as debris.

Among that debris, the researchers saw an unexpected blip of energy in form of an excess in pairs of photons, which had a combined energy of 750 gigaelectron volts (GeV).

The result lead to hundreds of journal article submissions on the mysterious energy signature - and prompted many physicists to hypothesise that the excess was a sign of a brand new fundamental particle, six times more massive than the Higgs boson - one that wasn't predicted by the Standard Model of particle physics.

But, alas, the latest data collected by the LHC shows no evidence that this particle exists - despite further experiments, no sign of this 750 GeV bump has emerged since the original reading.

So, we're no closer to finding a new particle - or evidence of a new model that could explain some of the more mysterious aspects of the Universe, such as how gravity works (something the Standard Model doesn't account for).

But it's not all bad news.

CERN researchers also announced that the LHC is now at peak luminosity - which means it's performing around 1 billion high-energy particle collisions per second, "so that even the rarest processes at the highest effective energy could occur".

It's also running at record-breaking energy levels of 13 trillion electronvolts (TeV).

Because of this, the LHC has already recorded five times more data in 2016 than it did in all of 2015, despite only running for a few months this year. Amongst those data is even more verification for the Higgs boson.

In other words, we may not have found any new particles just yet, but if they're out there, it's only a matter of time, because the LHC is running bigger and better than ever before.

"This is one of the most exciting times in recent years for physicists, as we dig into the unknown in earnest: the particle physics at an energy never explored before," said CERN Director for Research and Computing, Eckhard Elsen.

If you're really keen, you can start wading through some of the LHC results yourself to look for signs of new physics - the ATLAS experiment just releasedthe data from 100 trillion proton collisions from 2012 to the public.

Happy hunting.